Exploration of Instructional Strategies and Individual Difference within the Context of Web-based Learning

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Individual differences have been identified as important factors that might have significant impact on students' learning. This study investigated the effect of student's cognitive styles, achievement motivation, prior knowledge, and attitudes on student's achievement in web-based learning. A web-based course was designed for second year university students in an educational psychology class. Cognitive Style Analysis (CSA), Achievement Motivation Scale (AMS), and Attitude Scale (AS) were administered to a sample of 71 second-year university students enrolled in the educational psychology class. Findings of the study revealed that no significant differences (0.05) in achievement between field-dependent and field-independent students. Also, students with different characteristics learned equally well in web-based learning. The students enjoyed the convenience of web based learning. Competition and high expectation were the motivating forces in web based learning.. Prior knowledge and motivation seemed to be the only significant factors that explained more than 25 per cent of student achievement measured by class grade.

Individual differences, web-based learning, instructional strategies, educational computing

INTRODUCTION

The advent of the World Wide Web has changed the ways that teaching and learning have been conducted. Educators are now relying more and more on the Web as a platform for delivery, communication and interaction. One advantage of this new platform is that it takes into account the individual differences among the learners in different learning settings. One aspect of individual differences is cognitive styles. Riding and Rayner (1998) stated that identifying students' cognitive styles could help educators understand how people organize and represent information.

Chen and Macredie (2002) suggested that Witkin's field dependence/independence has emerged as one of the most widely studied cognitive style in different educational settings. Witkin and Moore (1974) used the term, field independence, to describe individuals who are individualistic, internally directed and accept ideas through analysis. On the other hand, field dependent individuals prefer working in groups, are externally directed, influenced by salient features and they accept ideas as presented. Research shows that field independent learners outperform field dependent learners in various learning settings owing to their different characteristics mentioned above (Ford, 1995; Ford & Chen 2000). As an instructional design sequence Witkin, Moore, Goodenough and Cox (1977) theorize that field dependent learners and field independent learners may perform equally well when learning materials are highly organized. They added that field

dependents might learn most efficiently when given guidance that emphasizes key information and draws attention to necessary cues.

As another individual difference, achievement motivation has always been reported to be an important factor in students' learning. Bandura (1986) defined motivation as a goal-directed behaviour that was instigated and sustained by expectations concerning the anticipating outcomes of actions and self-efficacy for performing those actions. Motivation was found to be the best predictor of student achievement in two studies, which investigated factors influencing student achievement in learning the Japanese language through the medium of satellite television (Shih, lngebritsen, Pleasants, Flickinger & Brown, 1998). In his study on motivation, learning style and achievement, Shih (1998) found that motivation was the only significant factor in web-based learning that accounted for more than 25 per cent of student achievement.

Prior knowledge is also an important aspect of individual differences. It can be defined as the knowledge, skills, or ability that students bring to the learning process. Prior knowledge has been found to have a strong influence on learning (Jonassen & Gabrowski, 1993). Research shows that 30 per cent to 60 per cent of difference in performance could be explained by prior knowledge. Perhaps learners with salient prior knowledge are able to employ highly effective acquisition strategies such as organisation, chunking and elaboration, and so become able to process and assimilate relatively high levels of information input without suffering overload effects whereas learners with low prior knowledge are unable to use such strategies (Alexander, Murphy, Woods, Duhon & Paker, 1997; Tobias, 1994). As compensation, different effective instructional strategies have been identified to help students with low prior knowledge to activate their existing knowledge. Such strategies might include brainstorming, general discussion questions and graphic organizers.

Based on the previous discussion, it seems that cognitive styles, achievement motivation and prior knowledge may have an effect on students' learning. However, more research is needed to help understand the nature of this effect and if there is any interaction among these variables within the context of web-based learning. Thus, this study is meant to:.

1. Investigate the effect of students' cognitive styles, achievement motivation, prior knowledge and attitudes on achievement in a web-based learning environment.

2. Examine the ability of web-based learning in accommodating different cognitive styles and enhancing students' learning.

METHOD

The initial sample of the study consisted of 71 second-year university students enrolled in an Educational Psychology course offered by the School of Education, the University of South Australia. Richard Riding's Cognitive Style Analysis (CSA) computer-based test was only administered to 53 students to determine their cognitive styles; either as field dependent or field independent learners. Riding and Rayner (1998) recommendations are that scores below 1.03 denote field dependent individuals; scores of 1.36 and above denote field independent individuals. An online survey was designed by the researcher and included two scales. A five-item motivation scale (Alpha=0.69) was selected from the Motivation Strategies for Learning Questionnaire (MSLQ) developed by Pintrich and his colleagues at University of Michigan (Pintrich, Smith, Garcia & Mckeachie, 1991). The students were asked to rate themselves according to how well the statements described them by using a five-point scale with response options ranging from (1) Not at all typical of me to (5) Very much typical of me. A six-items attitude scale (Alpha=0.86) was developed. Some items were taken from a questionnaire which was used in Shih's (1998) study on assessing biology students' attitudes towards web-based learning. The five-point Likert-

type scales had response options ranging from (1) Strong Disagree to (5) Strong Agree. The final examination grades of the two online topics were used as a measure of achievement. Students' achievement in a previous educational psychology course was used as an indicator of their prior knowledge.

A web-based course was designed for the educational psychology students focusing on two topics: Psychology of Science and Psychology of Reading and Writing. Owing to the fact field independent learners outperform field dependent learners in various learning settings due to their different characteristics (Ford & Chen 2001; Ford, 1995), we, in our design, have taken into account field dependent learners preferences by applying several techniques in an attempt to help them interact comfortably with the learning material and to minimize disorientation problems. Navigational cues and concept maps were used both to guide students through the material and give field dependent students a global picture on the topic and show relationships among concepts. In addition a graphic-based overview was used at the beginning of each topic in an attempt to activate students' prior knowledge especially of field dependent learners.

The study went through several steps. Initially, the CSA was used to classify students' cognitive styles as field independent or field dependent. Subjects were then asked to log on the website to undertake a questionnaire that measured their achievement motivation and then they proceeded to study the online course material. After going through the material they were asked to undertake another questionnaire, which measured their attitudes towards the web-based learning. Students were given a period of two weeks to use the website before they started their final examination. In the final examination, which was a paper-based examination, students' marks on the two topics mentioned were used as an indicator of their academic achievement. Data were analyzed with the Statistical Package for the Social Sciences (SPSS). Analyses of data included, means, standard deviations, t-tests, Pearson correlations and regressions. A significance level of $p<0.05$ was adopted for the study.

RESULTS

One-way ANOVA was run in order to test whether student's achievement motivation differed significantly with respect to their cognitive styles. As shown in Table 1, the analysis yielded non-significant difference ($p>0.05$, $F=0.05$, $df=1$) in student's achievement motivation.

Table1. ANOVA Test the Effect of Students' Cognitive Styles on Their Achievement Motivation

Achievement Motivation	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0.47	1	0.47	0.05	0.82
Within Groups	462.29	52	8.89		
Total	462.76	53			

Level of Significance is at 0.05

As shown in Table 2, no significant difference ($p>0.05$, $F=0.50$, $df=1$) was detected between field dependent and field independent students on achievement.

Table 2. ANOVA Test the Effect of Students' Cognitive Styles on Their Achievement

Achievement	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.84	1	3.84	0.50	0.48
Within Groups	396.18	52	7.62		
Total	400.02	53			

Level of Significance is at 0.05

Moreover, student's attitudes towards web-based learning did not differ significantly ($p>0.05$, $F=2.2$, $df=1$) by being field dependent or field independent, as presented in Table 3. Overall, students showed positive attitudes towards web-based learning. They positively responded to

statements related to the convenience of web- based learning (mean=4.19), the ability to control the pace of learning (mean=4.13), opportunities for learning provided by web-based courses (mean=3.35) and enjoying learning from the web-based lessons. The mean score of students' attitudes toward web-based instruction was 3.57 (sd=0.81).

Table 3. ANOVA Test the Effect of Students' Cognitive Styles on Their Attitudes Towards Web-based learning

Achievement	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	32.31	1	32.31	2.20	0.15
Within Groups	528.01	52	14.67		
Total	560.32	53			

Level of Significance is at 0.05

A Pearson correlation was conducted in order to test whether there was a significant relationship between the variables of the study and the results are presented in Table 4. The analysis detected a significant correlation between achievement and both motivation and prior knowledge (r=0.496, r=0.476, p<0.05) respectively. In addition, a negative significant correlation was found between student's attitudes and their achievement. Meanwhile, the analysis detected non-significant relationship (r=0.013, p>0.05) between achievement and cognitive styles.

Table 4. Pearson Correlations between Students' Achievement and Their Cognitive Styles, Achievement Motivation, Attitudes and Prior Knowledge

		Achievement	Cognitive Styles	Achievement Motivation	Attitudes	Prior Knowledge
Achievement	Pearson	1	0.013	0.496**	-0.296*	0.476**
	Sig. (2-tailed)		0.938	0.000	0.039	0.000
	N	71	53	71	71	71
Cognitive Styles	Pearson	0.013	1	0.028	0.185	0.044
	Sig. (2-tailed)	0.938		0.873	0.354	0.812
	N	53	53	53	53	53
Achievement Motivation	Pearson	0.496**	0.028	1	-0.233	0.399**
	Sig. (2-tailed)	0.000	0.873		0.108	0.002
	N	71	53	71	71	71
Attitudes	Pearson	-0.296*	0.185	-0.233	1	-0.132
	Sig. (2-tailed)	0.039	0.354	0.108		0.422
	N	71	53	71	71	71
Prior Knowledge	Pearson	0.476**	0.044	0.399**	-0.132	1
	Sig. (2-tailed)	0.000	0.812	0.002	0.422	
	N	71	53	71	71	71

Note: 53 students out of 71 undertook Cognitive Style Analysis test.
** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Pre-post paired sample T-test was conducted to test the effectiveness of the web-based learning package. The analysis as shown in Table.5 yielded a non-significant (p>0.05, t=-1.427, df=58) difference.

Table 5. Pre-post Paired Sample T-Test

	Paired Differences							
				95% Confidence Interval of the Difference				
	Mean	Std. Deviation	Std. Mean Error	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1 Pre-post	-0.186	1.00	0.130	-0.447	0.075	-1.43	58	0.159

Level of Significance is at 0.05

Further, we compared the pre-post test scores of students who used the package with those who did not use the package, by using One-way ANOVA, a significant (p<0.05, F=5.81, df=1) difference on the post-test scores was recorded but not on the pre-test scores (p>0.05, F=3.32,

df=1). Students who used the website had a mean score of 13.20 on the post-test whereas the mean score of the students who did not use the package was 11.63. One possible explanation for this result is that the use of the web-based learning package at least was effective in maintaining the achievement level of the students who used the website on the post-test comparing with the other students who did not use the website.

A regression analysis was conducted to determine the amount of variance in students' achievement explained by selected variables. The regression model was loaded first with the overall motivation mean score, which explained 10 per cent of the variance in achievement. Student's standardized pre-test scores were entered second into the regression model. This variable explained 15 per cent of the variance in student achievement and then the attitude and cognitive style variables were entered, explaining a very small proportion of the variance in achievement. Prior knowledge and motivation would seem to be the only significant variables that explain for the variance in achievement scores.

DISCUSSION AND CONCLUSIONS

The results of the current study seems to support what is asserted in literature, namely, owing to its features, hypermedia is more effective in reaching all types of students, and reducing differences in the academic performance among different student cognitive styles. Therefore we can confirm that web-based learning can accommodate a wider range of cognitive styles. Witkin et al. (1977) suggest that, in comparison with field independent people, field dependent people have more difficulties dealing with confusion, complexity, and dimensions that are often present in hypermedia systems. Thus, extra guidance may be useful in assisting field dependent people in hypermedia learning. Hence, it was our expectations that using a variety of instructional strategies in our design, such as presenting graphic organizers of content, concept maps, and salient navigation cues, would advantage field dependent students and help them to perform as well as their counterparts.

Furthermore, this study showed that students who used the website performed on the post-test better than those who did not use it. It might be the case that students who used the website spent more time studying the online course material besides the lecture notes. Another possible explanation is that the students might have found the material on the website more organized and much easier to follow especially when concept maps were used as an instructional strategy. One of the comments that we received from the students was that "this site has been an excellent help in the study process, and it would be excellent if all the lectures were available in this format as it helps to put the information into a clear context". Another student commented that "the concept map idea was helpful, because I could see how information was related".

In this study prior knowledge and achievement motivation explained 25 per cent of student's achievement. Prior knowledge has always been reported to have a significant effect on learner's performance. Statistical meta-analysis indicates that prior knowledge could explain up to 42 per cent of variance in performance (Dochy, 1992). It appears that prior domain knowledge is an important factor that can explain differences in students' performance. The importance of prior knowledge seems to be the resources it provides the student. Therefore, it is of considerable value for students to be equipped with relevant knowledge, and to have this knowledge activated at the very moment when learning is to occur (Yates & Chandler, 1991). Consequently, Web instructional designers should consider instructional strategies that can be used to activate student's prior knowledge. One way to do so is to provide concept maps or advance organizers that can activate their exciting knowledge and link it with new information being learned. Another approach is to allow students to share knowledge in small-group discussions prior to beginning a new and possibly unfamiliar task.

Motivation also appears to play a very important role in web-based learning. Instructors should understand the importance of motivation in web-based learning so as to enhance student achievement. In addition they should take into consideration strategies that can encourage students to become active and motivate learners in online learning where the ability of an instructor to influence motivation is greatly reduced because of the lost face-to-face contact with learner. Such strategies might include integrating Lepper and Hodell's (1989) four characteristics of tasks (challenge, curiosity, control, and fantasy) that promote individual intrinsic motivation. Another strategy could be using Web capabilities to facilitate communication among participants, such as using discussion board and videoconferencing, in order to provide opportunities to carry out cooperative and competitive strategies.

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